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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

UPES

End Semester Examination, December 2017

Program/Course: B.Tech / PSE **Semester: 3^{rd}**

Subject: Fundamentals of Fluid Mechanics **Max. Marks: 100**

Code: GNEG 218 **Duration: 3 hrs**

No. of page/s: 02

Note: The question paper contains section A, B & C.

Section A

Note: *Answer all the questions. Each question carries **5 marks**.*

1. Explain stream function and velocity potential function in fluid flow.
2. Express the Bernoulli equation (for ideal fluid) in three different ways using (a) Energies (b) Pressures, and (c) Heads.
3. Explain NS equations in x, y and z direction. Write also the vector form of NS equation.
4. List the type of major losses and minor losses in a fluid flow.

Section B

Note: *The first three questions are compulsory. Attempt any one from the last question(Q.8). Each question carries **10 marks**.*

5. The time period T of water surface waves is known to depend on the wave length λ, depth of flow D, density of the fluid ρ, acceleration due to gravity g and surface tension σ. Obtain the dimensionless form of the functional relationship using Buckingham Pi theorem. Select λ, g and ρ as repeating variables.
6. The stream function and velocity potential function for a flow are given by $\Psi = 2xy$, $\Phi = (x^2 - y^2)$. Show that the condition for continuity and ir-rotational flow are satisfied.
7. Calculate the shape factor for the given velocity profile of the flow.

$$\frac{u}{U} = \left(\frac{y}{\delta}\right)^{\frac{1}{7}}$$

8. A fluid flow phenomenon is to be studied in a model which is to be constructed by using Reynolds model law. Find the expressions for model to prototype ratios of velocity, discharge, pressure, work and power.

OR

Derive the Bernoulli equation when the compressibility effects are not negligible for an ideal gas undergoing (a) an isothermal process and (b) an isentropic process. State all assumptions clearly.

Section C

Note: *Q.9 is compulsory. Attempt any one from Q.10. Each question carries **20 marks**.*

9. (a) Explain plane Poiseuille flow, draw the velocity profile for the flow, discuss the effect of pressure gradient on the velocity profile and prove that ratio of maximum velocity to average velocity is 1.5 for the flow.

   (b) Show that Fanning friction coefficient is given by the formula $C_f = \dfrac{12}{Re}$ for this flow.

10. A vented tanker is to be filled with fuel oil with $\rho = 920\ kg/m^3$ and $\mu = 0.045\ kg/ms$ from an underground reservoir using a 20-m-long, 5-cm-diameter plastic hose with a slightly rounded entrance and two 90^o smooth bends as shown in figure 1. The elevation difference between the oil level in the reservoir and the top of the tanker where the hose is discharged is 5 m. The capacity of the tanker is $18m^3$ and the filling time is 30 min. First Check whether the flow is laminar or turbulent. Taking the kinetic energy correction factor at hose discharge to be 1.05 and assuming an overall pump efficiency of 82 percent, determine the required power input to the pump. State all the assumptions to solve the problem.

    The loss coefficient (in terms of number of velocity head) is $K_L = 0.12$ for slightly-rounded entrance and $K_L = 0.3$ for a 90^o smooth bend. If flow is turbulent use friction factor, f = 0.0370.

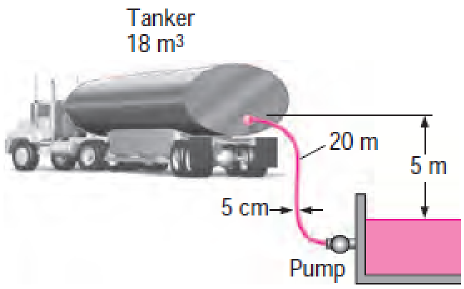

Figure 1:

OR

A centrifugal pump will be used to transport water at 10^oC from a lake to a cabin asshown in fig: 2. The discharge will be 38 lpm at an elevation of 18 m above the lake surface. Discharge pressure is atmospheric. The suction pipe is 5 m-long by 3 cm-diameter, and the discharge pipe is 60 m-long by 3 cm-diameter. Friction factor in each pipe is 0.05. Assume the kinetic energy correction factor in each pipe is 1.0. Determine the head supplied by the pump, pump power and sketch an energy and hydraulic grade line at point a, b, c, d and e.

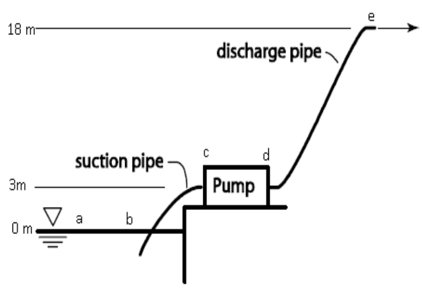

Figure 2: